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Bulletin of the

Society for the Promotion of Engineering Education

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THE LIBERAL ELEMENT IN ENGINEERING EDUCATION.

BY GEORGE F. SWAIN,

Professor of Civil Engineering, Harvard University.

I have been asked to speak on this topic, which has been selected, I assume, by some committee. I will endeavor to present briefly my views upon the subject. Let me first state some principles which may make the consideration of the subject easier, and focus differences of opinion.

1. In the words of that fine old English schoolmaster, Richard Mulcaster, who wrote over 300 years ago, which cannot be improved even today, "The end of education and training is to help nature to her perfection in the complete development of all the various powers." Its aim is to give the student power to meet the problems which life will bring him.

2. Education is strictly utilitarian, using the word in its widest sense. The student should be taught first what is necessary, second what is useful, third what is ornamental. All of these are utilitarian, or useful in the largest sense.

3. The objects to be aimed at in education are mainly two, viz., discipline of mind, and interest; knowledge is secondary, but discipline should be acquired in subjects which will bring knowledge with it.

4. No effective results will follow unless the student is interested and sees the value, use, and application of what he studies.

5. A student cannot appreciate what he studies, or become really and profitably interested in it, in a concrete way, unless he can relate it to his experience.

6. Education cannot turn out a finished product, that is to say, a man fitted to take a responsible position at once. It can only fit him to begin at the bottom of the ladder, and give him the foundation upon which to build. Experience is necessary before he can advance, but if he has a well-trained mind and the proper attitude, he should gain and assimilate experience rapidly, and progress much faster than otherwise.

7. We live in a world of other men. In order to make our way, we need, besides a disciplined mind, many other qualities, such as knowledge of men, tact, personality, perseverance, energy, enthusiasm, power to concentrate, ability to work hard and effectively, and above all, character. Education should aim to cultivate such qualities as far as practicable.

8. In education, much more depends upon how a subject is taught and the personality of the teacher, than upon what is taught.

9. Education may on the one hand be liberal or professional, or it may be vocational. The latter aims to fit young men specifically for some definite occupation, such as a manual trade, or for stenography, bookkeeping, etc. Professional education has essentially the same object, except that a profession is broader in scope and requires a stronger and broader foundation of general principles. Vocational education may be concerned mainly with training the body, or even one muscle, rather than with training the mind. Vocational education will not be considered here, but it may be remarked that it possesses in a marked degree one of the most important elements, namely, interest. The pupil becomes at once interested in the work, it is related to his experience, he sees the use and meaning of it all the time. Its results are therefore apt to be very satisfactory, even more so than the results of more formal education, and its importance is steadily increasing with the recognition of the fact that one of our main problems is to put the boy in the right place and fit him for some specific job.

10. Engineering education is in a sense vocational, but since the field of engineering is very wide, and rests upon a substantial body of principles of science, it must be broad and deal rather with those general principles than with any specific job. Yet the line between the two is not sharp, and many graduates of vocational schools make the best of engineers ultimately.

The question as to the liberal element in engineering education, or a liberal education by itself, arises from a recognition of the fact, above referred to, that since we live among men, an educated man should have some knowledge outside of his own vocation, of language, literature, history, and economics, so that he may understand and appreciate what goes on about him, that he may know something of the thoughts and deeds of the great men of the past, and may be able to write and to express himself clearly and logically. Without

these things, a man may have great skill and knowledge, but not attain his greatest usefulness or development.

The difficulty is that in the study of these subjects the student may not be able to relate them to his experience, that is, his work is not *motivated,* and so he achieves small results. The subject of this paper is mainly *motivation,* or doing work with a distinct motive, gained by being able to see what is being done, the need and use and application of it, which is only possible, if my view is correct, if it can be related to experience. It is a great fallacy to suppose that a boy will gain what is called culture by listening to courses of lectures, especially if he is not interested in them. Some of the most uncultured men are college graduates.

Few students take much interest in Greek and Latin. Those tongues are dead, and the student does not realize their significance in relation to our own tongue. Modern languages have more interest to him, because he can use them. History may interest him little because it does not deal with the present, and he cannot relate it to the present and coördinate it with his daily life. Economics he may think he can understand, because he hears it talked about so much, but since it deals with business questions in which he has had no experience, he really cannot grasp it concretely or safely. Science, mechanics and engineering he can understand, because he lives in a world of science and engineering, he can relate these to his experience; yet even in these subjects we take pains to relate them to his experience still more closely by providing laboratories. Even this is not always deemed a sufficiently close relation, and we employ the coöperative system, as at Cincinnati, where the pupil alternately studies and works in a shop and so is, as Mulcaster advises, "a-doing while he is a-learning." Mathematics, in arithmetic, he can relate to his experience, for he has to buy and sell and make change every day; but in its higher branches it is abstract to him, he does not interpret or grasp it, and this is perhaps the reason why so many boys hate it, unless it is taught and used

distinctly as a tool in connection with science and engineering, and preferably taught by men who themselves use it in their daily work.

It is of course true that there is such a thing as a stimulus lasting a lifetime derived from a single lecture, a single point of view, a single idea. But such a stimulus may as well be gained from a sermon, an academy lecture or a conversation with a friend. We should not judge a college course on such a basis, except that we should try to have stimulating teachers, who would look beyond the narrow confines of their subjects, deal with the individual student as much as possible, meet students outside the class-room, and try to influence not only their knowledge but their character.

The key to effective instruction, it seems to me, is motivation. Relate the subject to the student's experience. If it cannot be so related effectively, better not teach it. We make a common mistake when we assume that when a subject is put into the curriculum it is put into the student. We cram the curriculum full of every subject of human interest, regardless of whether the student can relate it to his experience. If he does not so relate it he will generally take no interest in it and get nothing out of it. If he does take an interest in it, it will often be by relating it, not to his experience, but to his imagination, and in this case he will get less than nothing out of it; it will do him harm. He will become a theorist who does not care for facts, but only for his imagination and his preconceived ideas.

Some subjects are difficult to motivate and should not be taught in school. History is often not related, if taught as a barren chronology of facts, but if made live by showing the causes and effects of great events, the tendencies of the times, and illustrated by the characters of great men, it may be one of the most useful of studies. But history cannot be related experimentally in the laboratory. Sometimes, in the laudable effort to motivate, ludicrous and time-consuming methods are resorted to, as when a class in American History was made

to "live" their history by building Indian wigwams. In such a subject everything depends upon the teacher and *how* the subject is taught.

Economics is difficult to motivate, since it deals with complicated matters of business, not within the range of experience of the student. I have long believed that the excessive teaching of this subject now quite common was not only profitless, but injurious, notwithstanding the intrinsic importance and interest of the subject. The student will frequently find in this subject his own teacher, an eminent man, holding opinions diametrically opposed to those held by an equally eminent teacher at a neighboring college, while neither can be demonstrated to be in error. What a field is here for the cultivation of a dependence upon preconceived ideas, even if contrary to facts! The inherent importance of the subject may enlist the interest of the student, but he cannot relate it to his experience, and so relates it to his imagination or his sympathies. His sentiment is stronger than his reason, and he becomes a faddist, indulging his preconceived ideas at the expense of society. Perhaps no subject depends so much upon having a safe, logical, unemotional teacher, himself experienced in business affairs or capable of seeing them without distortion. One brief course in the subject should suffice to give the student an idea of its scope, methods, and general principles, and an outlook over the problems with which it deals, sufficient to serve as a basis for later study, as he gains experience in the business world.

I was talking last summer with a young banker, who had taken in college, in anticipation of his career, a course in banking and finance. He said that he got absolutely nothing out of it, and, furthermore, that he knew his classmates well, and that none of them had got anything out of it. The teacher had had no banking experience, was a theorist, and shot entirely over the heads of the students, who did not have the faintest idea what he was talking about.

If the subjects in economics and sociology could be taught

as my friend Professor ———— teaches them, all might be well. The student would gain safe, sensible views of very important problems, and might learn to see the fallacies in many current and plausible economic theories. Yet even so, he would be exposed to the danger of discovering that his teacher held views perhaps not commonly accepted, and so he would still run the risk of allowing his preconceived ideas, or his sentiments, to govern his views, rather than reason and experience. And then there are Scott Nearings in our colleges, whose influence might be not only little, but positively vicious. A bad teacher of science, or of mathematics, or of engineering may do little good, but he can hardly do positive harm. At the most the student learns nothing from him. But a bad or unbalanced teacher of economics may do positive harm, in inculcating unsound and vicious economic theories into the minds of immature students who have not the experience nor the trained logical minds to discover the errors. The best training for the study of economics, I think, is a training in science, so that demonstration may be distinguished from hypothesis, and truth recognized when found. A subject on which opinions differ widely, while few can be demonstrated to be correct, does not appear to be a good one for an immature and untrained mind, though it may be a very useful subject of study for a mind already trained in logical methods, and with experience as a guide. Personally, I believe that the excessive study of economics in our colleges, and the turning out of large numbers of young men who have "specialized" in this subject, and who go out into the world thinking they know all about these great questions, though totally without practical experience, and without training in scientific methods of investigation as well, is one of the most serious menaces to our country. You cannot experiment by the scientific method in economics, because you cannot vary one element only. There are always many elements, the relative influence of which cannot be measured. After a young man has studied science thoroughly, has learned the scientific

method, and has acquired the scientific attitude of mind, it is time for him to study, in detail, the great questions of economics, and not till then.

Some branches of economics may be motivated. One of these is accounting. Every boy keeps, or should keep, a cash account, and the study of double entry book-keeping is not only a means of excellent mental training, and of the principles of accounting, but is eminently practical. The same is true of the elementary parts of other branches. The engineering student should be taught what a bank is and does, how he can use it, the methods of promoting and organizing a business enterprise, the different kinds of securities, and so on. Some topics connected with business management, the methods of securing efficiency, the importance of cost data, may also be taught to advantage. The elements of business law may also be appropriately included.

The classics have gradually been falling into disrepute as liberal studies. Nevertheless, I have always been disposed to value them highly; not so much for the language itself, although that is important as a basis for our own, but more for the acquaintance which the study gives with the literature of a great epoch, and the characters and thoughts of great men of the past. I agree entirely with the views of Senator Lodge in his remarkable address last year at the Princeton Conference for the revival of classical studies. Yet I think perhaps Senator Lodge makes the mistake of assuming that because of the importance of these things they will be gained by a college course. Doubt on this score may be suggested by his own words, in his "Early Memories," where he writes of his college course as follows: "But in all my four years I never really studied anything, never had my mind roused to any exertion or to anything resembling active thought until in my senior year I stumbled into the course in mediæval history given by Henry Adams." He also says that although "college is supposed to be a place primarily if not wholly for education and the improvement of one's mind" he got very little

of either, and that his "greatest and most profitable enjoyments were derived from the many friendships (he) then made or continued." We also remember that Emerson said that the boy goes to college to be taught by the professors, but it is his classmates who educate him.

One of the best of liberal studies is English, particularly if including a course in Logic. Surely few things are more important to the engineer than the ability to write a good report, and to express himself clearly, forcibly, concisely, and logically. But the course in English should not be the traditional course. It is of little importance to the engineering student whether Keats was a greater poet than Shelly; but if the student is led up to the study of good writers through his own experience in trying to express himself, or by seeing the relation of the subject he reads about to the necessities of his own profession, he will gain an interest heretofore often lacking. Some courses in English are now being conducted in a way to secure this result.

But in recognizing the importance of liberal studies for engineering students, or for any students it may be proper to say a word as to the importance of science, for students of liberal arts and other than scientific professions. Of all studies, the sciences and their applications are probably the best and most useful, as a means of discipline, for their motivation, and for the knowledge and even character that they impart. This has been shown at length by Herbert Spencer in his book on education. The sciences offer all the elements of logical analysis, hypothesis, experiment, verification. They are not rigid, like mathematics, but afford room for doubt, hypothesis and argument. Neither are they vague and incapable of demonstration—mere matters of opinion—like many branches of economics. Moreover, every youth should have disciplined knowledge of the world in which we live and the physical phenomena which he experiences every day. Yet in some of our colleges it is possible for a boy to graduate without taking in college a single course in natural science

or in mathematics. If I recognize and urge the importance of liberal studies, and even of the classics, for all broadly cultivated men, I must even more urge the importance of science for every man. I believe that in our colleges we are committing the great mistake of neglecting science in favor of economics, sociology, and literature, which are far inferior in disciplinary value and in power of motivation.

The effect of the war on education will no doubt be great. It has already taught us that many things previously thought impossible can be accomplished. It seems to me that its effect on education will be to cause us to make our work more efficient, by making it more practical, more directly useful, and to motivate it as far as possible.

In engineering education by far the greater part of the time must be devoted, as formerly, to professional work. Liberal studies must remain secondary, and occupy but a very small part of the time, but they are especially in need of motivation. I think they will consist mainly of thorough work in English; some modern languages, which will now be of greater importance than heretofore, unless these can be taught in the preparatory schools; some history, treated especially in the light of the great events we have been witnessing; and a brief general course in economics, supplemented by accounting and some treatment of banks, securities, organization, business law and business management. These subjects must all be treated in such a way that the student will relate them to his experience, and will look upon them as live realities, important to him in his profession, and forming part of the intellectual equipment and training of any broadly trained man. The courses in economic subjects should be put in the last year of the course, so that the students will be as mature as possible, and will have previously had a training in science. But along with liberal courses should go a greater liberalism in technical courses as well. There are few exercises in technical subjects, unless they are purely lectures, that will not give the qualified instructor an opportunity to illustrate some

moral or economic or logical point outside the narrow scope of the course. If the instructor has a knowledge of history, biography, economics, and business, he can vivify even dull technical details by their aid.

The motto for the future, it seems to me, is—Make the instruction practical, useful, and well within the comprehension of the students and the field of their experience—motivate it.

THE EFFECT OF THE WAR ON ENGINEERING EDUCATION.

BY C. R. MANN,

Head, Educational Department.

The Society for the Promotion of Engineering Education has always been a leader in college education. It was the first association formed among college teachers for the purpose of studying their teaching problems. Its meetings are always the most interesting of educational gatherings and one of its committees discovered the clue that gave the schools their opportunity to help win the war. Now that the fighting has ceased, it is fitting that this Society should take the lead in conserving the benefits that have accrued to education because of our participation in the struggle.

It must be obvious to everyone that as yet the war has had but little effect on education. For the first year, the schools preserved their academic routine undisturbed. Their subsequent experience with war training has been so brief that no settled habits have been acquired and permanent results will be secured only if the schools resist their natural tendency to relapse to their placid peace time procedures. In the past America has made many good resolutions in time of stress only to forget them when the national crisis was past. Hence before attempting to interpret the present war experiment with education or to appraise the profound changes wrought by the war in our national philosophy of life, it is well to remind ourselves of previous reactions on other similar occasions lest the benefits of the present soul-stirring adventure escape us.

In the pioneer days of the Pilgrim Fathers, the first school law of the Massachusetts Bay Colony (1642) authorized the expenditure of public funds for vocational education because

it was of benefit to the commonwealth to train children in the manual arts. Again, in the midst of the toil and turmoil of the Civil War public funds were voted for the support of training in agriculture and the mechanic arts; and when in this present crisis the dependence of the nation's strength upon its mastery of materials became evident, the treasury was opened to develop manual skill and tool power, without which the nation could not wage war. The emphasis on ostentatious and cultural studies that distract men's minds from the rugged realities of existence was for the time being transferred to the mastery of the forces of nature through machines by which men magnify their strength.

The pioneer experiences of 1642 and the civil struggle of 1862 recognized the need for productive skill by passing laws, but they did not succeed in developing a technique of administering practical education. Such a technique has been striving for expression since the founding of the engineering schools. This war has crystallized the results on a national scale. On April 10, 1918, 10,000 young men were called to national service by the War Department and placed in schools for two months of intensive military and technical training. Most of the schools were reluctant to undertake this work because their traditions led them to believe that little could be accomplished in so short a time and because the type of work required was unconventional and not generally considered to be of university grade. The army's need, however, was great and the institutions from a sense of patriotic duty undertook the work with fine spirit and with a will. We are all familiar with the results. By June 15, 50,000 men were in training at 155 schools. This number was continued through the summer, graduating each month 25,000 men prepared for service as technicians in the army. Before the signing of the armistice, 130,000 men had been so trained and contracts had been let for training 220,000 more.

The method of training employed was one that has been successfully used in army and navy training stations for many

years. It is based upon the conception that all men in the army are primarily soldiers, each with a specialized technical skill that may be relied on when emergency requires. Therefore, each man must be resourceful and eager to do his best under any conditions, besides having a certain degree of manual skill. To meet this requirement, a course was designed consisting of a combination of military drill, practical shop work and humanistic study. The military régime developed the men as soldiers, the shop work added practical skill, and the humanistic study gave them an understanding of why they were fighting.

Before beginning the instruction, a careful survey was made of the needs of the army in order to determine as accurately and definitely as possible the specifications for every job which soldiers were to be trained. The shop work was then planned to teach each man to do the particular job for which he was best adapted and for which he was to be held responsible in some army organization. The instruction consisted in a series of projects carefully graded in difficulty and requiring the exercise of ingenuity and resourcefulness for their accomplishment. In other words, the soldiers were taught to do by doing under conditions that resembled as closely as was practicable real army conditions. The ordinary manual training system consisting of a set of predetermined exercises in the fundamental operations of machine shop practice was abandoned as unsuited to this particular task.

In like manner, the humanistic work was designed to answer the many questions asked by the soldiers concerning the issues of the war. The class work was a continuous discussion of these questions accompanied by outside reading by means of which the student could secure the facts and information that would enable him to answer his own questions intelligently. Some forty thousand of the soldiers' questions were collected, sorted and classified and a brief manual issued which contains the most frequently asked questions together with references to documents in which the answers may

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be found. This course was not in any sense a propaganda for any point of view but an effort to help men to discover the facts that would enable them to draw their own conclusions on the larger questions involved. The course was also unconventional in that it was not given by any one academic department but by the coöperation of the best men in all the different departments involved.

From the large mass of testimony that has accumulated in the past few months from both the army and the schools, it appears that this organization of technician training has proved highly successful. Military officers assure us that after two months of this combined training, the men have made as good progress in their military work as is ordinarily the case after two months devoted to military training alone in the cantonments. In the shop work, the men have acquired skill and understanding of their problems at an amazing rate. Bank clerks and barbers, salesmen and many others who had never worked with tools before have been converted in this shore time into satisfactory technicians for army use. The war spirit, the reality of the work, the progression from application to theory and the snap of military discipline have all conspired to achieve results that before the war were pronounced by the schools to be impossible.

The experiment of training young men for officer training camps in the Students Army Training Corps in colleges, which was begun on October first, has not yet had time to demonstrate the effectiveness of the methods employed. Interrupted as it was for three weeks at the beginning by the influenza, it had only three weeks of actual trial. While in many cases considerable difficulty was experienced in adjusting the military with the academic routine, eighty-five per cent. of the schools have just expressed their desire to retain the system to the end of this academic year. Unfortunately, this cannot be done because the removal of the military necessity that makes it impossible to utilize the appropriations to carry the experiment further. All that can be said is that in

many places the indications are that good results were being obtained, while in others the reverse was true. No final conclusions are possible.

The sudden conversion of the engineering colleges into military schools and their equally sudden reconversion to civilian schools, have left them in a wholly disorganized state. It is therefore a most propitious time to reorganize them and to be guided in this reorganization by the lessons learned from the war experience. Besides the specific lessons as to methods of instruction and organization, demonstrated by the experience with vocational training, changes in the national philosophy of life are developing certain large new conceptions that have been gradually taking form and are now fairly well recognized as guiding principles for future development. Since this is an engineers' war, the engineering schools are particularly responsible for altering school practice to accord with these principles. It may safely be said that the future progress of this country depends in large measure upon how successful these schools are in this new enterprise.

In order to discover the guiding principles, our war experience may conveniently be analyzed under two heads, namely, (1) production of soldiers; and (2) production of supplies. In meeting the first of these requirements we have had little difficulty and delay. The Selective Service Law and the effectiveness of the military training methods have made it possible to transform civilians into soldiers in a remarkably short time. War is the most impersonal of all great issues and men are eager to subordinate their petty private ambitions to the one paramount purpose of victory. Military training and organization are the most effective means of accomplishing this end and friends and foe alike are lost in admiration at the speed and perfection with which this transformation was accomplished.

But while military training methods have proved efficient in the high speed production of soldiers, the fact remains that ships, airplanes and clothing have not materialized as rap-

idly as the soldiers required them. No official reports are yet available excepting in the case of aircraft production and this report indicates that the delay was due to the difficulties inherent in organizing a number of individual industries into a military unit consecrated to the single purpose of production. Such information as is available, indicates that the same is true with regard to ships, clothing and other supplies. In spite of the patriotic response of manufacturers and transportation managers as individuals, it was a relatively long and tedious process to subordinate to the public interest the private interests of numerous industrial companies and to coordinate them into a single production plant organized for the sole purpose of maximum production at minimum cost. In the case of the railroads the Federal Government had to take legal control before the result could be secured.

From these experiences it appears that the regimentation of individual men in military units, when required as a measure of preparedness for a future emergency, can be accomplished in a relatively short time. The personal willingness of individuals to serve their country, the local public sentiment against slackers, the respect for the uniform and the glamour of war, all stir the emotions and inspire men to make a concerted drive for national integrity. But corporations are less susceptible than individuals to personal emotions and enthusiasms and are therefore slower to subordinate their "lives, their fortunes and their sacred honor" to national welfare. Therefore any system of universal training which only drills individual men as soldiers, but which does not include as its major feature the reorganization of industry so that it will be capable of mastering production on a national scale, will be a partial and wholly inadequate solution of the problem.

The reorganization of industrial production is a task requiring a type of engineering ability that is at present very rare. It is the function of the technical schools of the future to develop men who can and will accomplish this intricate

task. As at present organized the curricula are not designed to secure this result, because their avowed aim is to impart knowledge of the laws of physical science and of the properties of materials. But if we are to accomplish this task, we must add to this knowledge an understanding of the methods by which human wills are coördinated for team play not only in individual organizations but also in national enterprises.

The engineering schools have already recognized the necessity for instruction in human relations, as is evidenced by their recent introduction of courses in economics, sociology, industrial management and engineering administration. The mere superposition of these courses on existing curricula is, however, but a temporary palliative, because the reorganization of industry on the basis of national production involves a fundamentally new point of view, the implications of which reach to the foundations of our whole industrial system.

The larger outlines of the coming industrial system are now emerging from the toil and turmoil of the war. For when the war began everyone was certain that it could not last long because the bankers would stop it. Now everyone recognizes that the fighting continued so long as adequate supplies of men and material were maintained. This means that national strength in war depends upon production of men and supplies rather than on the financial system. Therefore, engineering, not banking, is the foundation of democracy's power.

But the war has not only made clear the general outlines of the new industrial system, it has also indicated the methods by which engineering schools can train engineers competent to meet successfully the heavy responsibilities that are from henceforth theirs. For although no conclusions are yet possible concerning the details of organization and administration of any plan that will meet the new conditions, the war experience seems to indicate that the following are the steps most likely to lead by experiment to conclusions of sound merit.

1. The War Department's experience with training soldiers shows that the first essential of effective teaching is a clear definition of the result desired. Theoretically, the schools have built their curricula to supply the elements required by the various types of engineers. As a matter of fact, however, much of the information and many of the methods now used in engineering schools are neither essential nor useful to engineers. If the courses are to be modified to place emphasis on production rather than on knowledge of the laws of physical science, new specifications of the essential factors will have to be written. This may be done by each school from a study of the actual operations of engineers in productive enterprises in their vicinity, or by joint action of national engineering societies such as this. No really intelligent changes can be made until there is a clear answer to the question: what are the specific requirements for each different type of engineer?

The war experience indicates that the definitions previously used for this purpose are too vague and uncertain to be expressed in intensive and effective work. It is also manifest that these definitions cannot be made by conferences of committees or by academic discussions at meetings like this, but only by actual and persistent study of the facts in the field.

2. A second inference from the war experience is that the content of the courses and the methods of instruction must be organized in such a way that every fact presented and every problem solved is relevant or contributes in an obvious way to the acquisition of some information or the development of some power required or mentioned in the specification. The conclusion of psychologists agrees with the experience of the war instruction that knowledge is always specific and is developed best by mastery of specific tasks.

3. In the third place, real military training and discipline have been demonstrated to be an essential element in the training of every engineer. Much confusion exists on this point because military training is often thought of as close

order drill and manual of arms, guard duty and other "stunts" of this sort. These are but the superficial forms of military discipline. The purposes of the entire military machine are to keep men physically fit and to train them so that each willingly subordinates his own individual desires and efforts to a common purpose to be achieved by the entire group. So far no better method than military training has been discovered to produce this result. But the result is as important in civilian enterprises as it is in war. Therefore careful consideration must be given to the question of how much military training is desirable or what better substitute, if any, can be found to accomplish the all important results of sound physique and discipline in subordinating petty personal desires to the welfare of all.

4. The army has long recognized that soldiers are better fighters if they have an intelligent conception of the issues of the battle. Many experiments have been made by the War Department to find ways and means of developing morale, but so far none has been more successful nor seemed more promising than the war issues course which has already been described.

For years engineers have been struggling to gain recognition as members of a learned profession. To this end, much has been written concerning the necessity for more intimate contact with the humanities in engineering schools. The question is here raised whether the introduction into engineering curricula of a course designed along the lines of the war issues course, but dealing with the issues of peace, might not be the best method of solving this intricate problem for engineers. The humanistic needs of the engineer are not satisfied by the current practice of requiring several years of linguistic training and brief courses in modern history or economics. Is it not possible that a course in which the wealth of material in history, in literature, in art and in philosophy was focused about the modern burning issues of peace might prove to be a most effective way of broadening the outlook of young men

who are specializing in the highly technical branches of applied science? In order to facilitate experiment along these lines the War Department has arranged to supply the schools with materials dealing with the peace conference, the formation of a League of Nations and the reconstruction of our industrial system.

5. The final large contribution of the war experience to educational practice has been made by the army in the field of rating, testing and classifying men by objective methods. The army test for general intelligence has been found a most valuable method of selecting and classifying men for all sorts of army work. In one hour's time this test yields results which correlate so highly with the results of many months of personal experience with the men that all recruits are now required to take it when they enter the service.

In conformity with this general practice the War Department was about to require that all students in the Students Army Training Corps be given this test and that it be used as one of the factors in selecting men for admission to the corps and hence to college. The sudden and unavoidable demobilization of the corps has necessarily interrupted this experiment but it is believed that the schools will find it a most useful one to carry further. The Committee on Education and Special Training is prepared to supply the necessary blanks and instructions for schools that wish to make experiments with this test.

Examinations are generally used in schools for the purpose of debarring non-conformists from academic recognition. The use of tests as an incentive to good work and as a means of releasing creative energy has been but little recognized. The reason is perhaps that ordinary examinations do not really measure ability but rather the degree to which the student has conformed to the personal bias of individual professors. Certain it is that students understand full well how to "get by" examinations as now given. On the other hand, the test of the football field commands their profound respect

because it is an objective "show-down" in competition with men who are recognized leaders. The new army tests are also objective. They open to the schools great possibilities of using their testing machinery as an incentive to spirited work rather than as a sieve for misfits.

6. Perhaps the most striking fact of the War Department's experience with education is that the federal government was willing to spend two hundred million dollars in one year on education. No such single appropriation for education was ever made in this country before. The reason is very simple. The national need was great and the schools had proved by their training of soldier mechanics that they could be relied upon to meet the national need. The primary purpose of the training was that each individual might be better equipped, not to realize his own personal ambitions but to serve the nation more effectively. The experience points to the conclusion that the public is ready to spend unlimited funds on education provided it is obvious to the taxpayers that thereby community, state and nation are being effectively served.

THE REQUIREMENTS OF A COURSE OF TRAINING IN NAVAL ARCHITECTURE.

BY LAWRENCE B. CHAPMAN,

New London, Conn.

The present revival of shipbuilding in this country is bound to call for the establishment of new courses in naval architecture and the remodelling of the existing ones. For this reason I am prompted to place my studies and observations as a student, teacher, and naval architect before the engineering profession. The following views and recommendations are partly my own, and partly the collected opinion of a large number of men active in the profession, with whom I have been thrown in contact. The attitude of the student, and the early careers of the graduates indicate that the present system of training in naval architecture is in many respects deficient. In the following article I shall point out these deficiencies and outline a course in which they are eliminated.

The first requirement of a course in naval architecture, as well as in any engineering subject, is that only those who have the necessary qualifications should be encouraged to pursue it. By this, I do not mean that one should pass his entrance examinations successfully, although this of course is essential; but that the student have the necessary acquirements and proper temperament for the calling. He should show by his boyhood activities and interests that he has a natural bent for the profession; he should have a clear-cut conception of the nature of the duties that one in this line will be called upon to perform; and he should be fitted by ability and mental caliber for the work required in the engineering profession. In short, he should feel that he is claimed by the profession of naval architecture and not choose it blindly or in a haphazard manner.

Many times these qualifications are almost impossible to determine or analyze and, at the least, require much study and guidance. At present practically no attempt is made to guide the student in his early years. The universities and our Society especially could perform a great service by reaching out into the high schools and help guide the student in the selection of his life work.

While on the faculty of the University of Maine, I had personal talks with most of the upper classmen in my classes and many other students in the engineering courses of the university. The number of men who had chosen a particular branch of engineering without any worthy reason was almost beyond belief. Some had the proper qualifications to make good engineers if directed into the right field; others had none whatever. Any one who has been in a position to observe students floundering in the first years of their training must realize the need of serious attention to this requirement.

Later I shall discuss a system in which the student spends a year at practical work before entering college. By following this scheme the student acquires a wonderful insight into the requirements and duties of the profession he proposes to follow, as well as a knowledge of his own temperament and bent. It is one of the best methods possible of solving this difficult yet basic problem.

The second requirement is that the course of training be so laid out that a man will obtain a well rounded education and broad outlook, to fit him for the duties of a naval architect, shipbuilder, or ship operator. This should include the fundamentals of science and engineering; the technical design and construction of ships and marine engines; the management of the shipbuilding industry; and the operation and maintenance of ships. In addition to these purely professional subjects the course should include a fair amount of general education.

These subjects should be considered not only from the technical standpoint, but also from the practical and econom-

ical standpoint and the point of view of the business man. Such topics as initial cost, overhead expenses, cost of operation of ships, size of ship and earning capacity, types of machinery to install in a given vessel for a given trade, time required in port for unloading, etc., are all problems that the naval architect should be able to handle. The naval architect of the future will find these questions of equal, if not more importance than the more strictly technical problems of his profession.

In order that the student may master the essentials in the whole field of naval architecture, requires that he be in close touch with the practice and business management of shipbuilding and ship-operation from the very beginning of his studies; as well as pursue the customary course of study in college. It must be borne in mind that the student is preparing himself to earn a living in a world of business and the sooner he learns its methods and demands, the sooner he will meet with success in his profession.

To attain this end, practical work in the industry, by cooperation between the school and the shipbuilding plants and steamship lines, should be included in the course of training. The two existing courses in this country at the Massachusetts Institute of Technology and the University of Michigan do not take this point of view and I believe in this respect that they are weak.

One of the requirements for graduation should be that the student put in a certain amount of time in various capacities in the shipyards, engine works and at sea. A number of ways are open to accomplish this. One scheme which is followed pretty universally in England is to require several years of practical work before entering the technical school. Many of the leading men in naval architecture in that country started their training as apprentices in the dockyards. After several years of practical work and instruction in the yard school, they enter the technical school. The corps of naval constructors for the British Navy is educated in this manner. The

achievements of such men as Sir William White and Sir Philip Watts certainly indicates that this method has considerable merit. As far as I know, this method is not used at all in engineering education in America.

The well-known Cincinnati plan, of two weeks in the industry followed by two weeks in school is another solution. The English "sandwich system" of a year in school alternated by a year in practical work is of the same character. Both have been criticized because the class room work is broken up and serious interruptions are introduced into the curriculum.

A third scheme is that of requiring practical work during the summer vacations. This system is already in use in some of the schools in this country.

From my own studies, I believe that a combination of the first and last schemes, requiring one year of practical work before entering college followed by three summers of work in the yard and at sea would accomplish the best results. This would give the student an insight into the profession and a tangible interest in the school work at the very start. It would either spur him on to better work in college or show him, before it is too late, that his real interests do not lie in the field of naval architecture.

It is very essential that all this practical work be directed by the college faculty and thorough coöperation, as in the Cincinnati plan, exist between the school and the shipbuilding and shipping industries. Otherwise the time of the student will be more or less wasted and the desired results will not be accomplished.

With the proper directing and planning of the high school work the course could be shortened so that the year of practical work need not necessarily lengthen the educational period. This, however, is not always possible or advisable and in such a case an extra year would be required. But the student who puts in an additional year in this manner should be further advanced at graduation than the student who has not; and in the end the period training will probably be shortened.

It is extremely important that the boy be guided in this year between high school and college; otherwise, as already mentioned, the time will be practically wasted. Care should be taken to see that his habits of study are not broken up, by prescribing a course of study and reading. I realize that the accomplishment of this plan requires earnest consideration and is not as simple as the mere statement might indicate.

The requirement in practical work should include experience in shipyards and shops where methods of construction and handling material can be observed; and experience in the drawing and designing offices where plans and technical calculations are made and material ordered. Then, some time should be spent in the shipyard offices where there is an atmosphere of business. Finally, a short time should be spent on shipboard where the handling of ships and their machinery can be studied. This part of the training will also give the student an opportunity to observe the action of a ship at sea which will cause him to take a more appreciative attitude towards the class-room work in stability and the strength of ships. If possible, a few weeks experience in a steamship office should be included in the training; so that the methods and practices of a steamship line can be observed.

If the above plan of practical training is followed, practically all the shop work can be dropped from the school curriculum. This will allow the time saved to be used for courses in literature, history, economics which at present are not given enough attention.

The practical work in the course as outlined would require about a year and a half of training outside of the class-room. I do not mean to assume that in this short time the student would become conversant in all the fields mentioned or become skilled in any trade or branch of the profession. In fact, I fear that he will have a rather superficial knowledge of the whole field, perhaps obscure in some particular branch. Nevertheless, he will have observed much that will incite his study and interest; he will have acquired unconsciously a knowledge

of proportions and dimensions of machinery and structures that will be invaluable in his college work. He will have mixed with men of all classes and learned their point of view which is of prime importance for one who may in the future be placed in charge of men. Most important of all he will have seen the industrial world in operation and be infused with its methods and spirit.

Having considered the practical side of the training, let us now turn our attention to the school curriculum. The professional studies should begin at the start of the freshman year and not left until the third and fourth year as is the rule at present. I do not mean by this that an advanced study of naval architecture should start the first year, but that short introductory courses should start. The professional work should begin in an elementary way and gradually become more technical as the student masters the necessary foundation work in mathematics and physics. If it is unadvisable to start the work in naval architecture, due to the fact that the students have not decided on their course definitely, introductory work in general engineering could be given, paralleled by simple work in the laboratory.

There are three important reasons for starting the professional work early in the course and are of paramount importance when the practical work is to follow the scheme I have just outlined. First, it is necessary that the professional work parallel the outside training so that one will be an explanation and complement of the other; second, the students enthusiasm and interest in his life's work must be aroused early and kept constantly at the highest pitch so that he will get the most out of his course of training; and thirdly, these introductory courses will teach the student his limitations and give a greater incentive to master the more abstract sciences which are necessary in order to master the theory of naval architecture.

English should also start the first year and continue throughout the four years. The students' experiences and

observations in his outside work will make excellent subjects for compositions and take away much of the antipathy that the student has for this subject.

Aside from these two considerations the present lay out of the freshman year in most engineering schools fulfills the needs of the first year of a course in naval architecture. In arranging the course, however, the practical work just completed and the summer work to follow should be kept in mind; so that the outside time will be spent to the best advantage.

The second year should follow more or less the same outline as given in the course of naval architecture at the Massachusetts Institute of Technology. More professional work, however, should be included and a systematic study of naval architecture and ship construction should commence.

By the time the student reaches his third year he should be familiar with the principles of ship construction, the drawing and fairing of ship's lines, and the making of half models. He should also have covered the elements of naval architecture and general engineering.

The third year should start out with a technical study of ship design and the more advanced study of naval architecture. About the middle of the third year an actual problem in ship design should be started which should continue through until the end of the fourth year and parallel the theoretical work of the course. This problem should consist of selecting of the proper proportions and dimensions to meet an assigned condition. It should start with a preliminary estimate of weight, stability, power, etc. Next a preliminary set of lines and arrangement plan should follow. Finally, a certain amount of the construction plans should be drawn and the final calculations for weight, trim, stability, displacement and power carried out.

It is extremely important that coefficients and data from good practice be available and the student taught to apply these to his design.

This problem cannot be carried through as it would be in

practice because many of the subjects will not always be taken up in class in time to be worked into the problem at their proper sequence.

The following subjects should be worked into the problem and illustrated by examples from practice: tonnage, freeboard, location of bulkheads and flooding of compartments; cargo and deadweight capacities, and Lloyds or similar construction rules; longitudinal strength and rolling period; stern lines and propeller bossing. Consideration should be given the power and propeller calculations and careful attention paid to the proportions of the boat, number of screws and revolutions of the engine for the most economical performance of the ship in service.

The course in marine engineering should take up such subjects as the selection and arrangement of the propelling machinery and auxiliaries; the heating surface, evaporation and fuel consumption of the boilers for a given steam consumption. After these points have been incorporated into the problem a consideration should be given to the economics of steam engineering. This should cover such subjects as fuel consumption for various types of propelling machinery, boiler economy, feed heaters, economizers, effect of leaky condensers, etc. These are all problems given careful attention in power plants on shore but too often overlooked on shipboard. A good naval architect should be well versed in steam engineering and should be taught to study the economical problems of the machinery as well as those of hull design.

Other subjects covered in the third year should include advanced mechanics, steam engineering and laboratory, electrical engineering, hydraulics, metallurgy, English, and economics of engineering.

In the fourth year the design problem should continue and the more advanced parts of theoretical naval architecture taken up. Some attention should also be given to heating and ventilation and aëronautics. A considerable portion of the year should be given over to marine engineering, including

engine design, steam turbines, boilers and diesel engines. The importance of studying these subjects from the economic point of view has already been mentioned.

By the fourth year the student should be able to choose for himself what division of the field of naval architecture he hopes to follow. Highly specialized options in ship design, shipbuilding, and ship operation should be introduced in the last year. This should be the only place in the course, however, where specialization is allowed, for the young engineer can seldom foresee what trend his career is likely to take.

In addition to the subjects mentioned, some time should be given in the training to yacht design, for its value in teaching the form and "sweetness" of ship's lines; and to cover the essentials of this field in case a student elects it as his life's work.

The course in economics after covering the fundamentals of the subject should take up concrete problems in connection with the work in naval architecture. Such a problem as steam vs. diesel engines for a given trade route and given vessel could be discussed with regard to first cost, ability to obtain a supply of fuel oil, cost of operation, depreciation, repairs, etc. Or again, a problem on the size of ship for a certain trade could be taken up and such points as interest on investment, time required in port for loading and unloading, and opportunity to obtain a cargo, considered.

Such a course would require coöperation between the instructors in economics and naval architecture and talks by men actually engaged in shipping. The department of naval architecture could also introduce at this time the economic consideration of the design problem already underway.

The foregoing briefly outlines the field that should be covered for a training in naval architecture. Before concluding I wish to add a few remarks as to the method of presenting the work. Too many of our engineering schools attempt to cover too much ground; and the result is that the student graduates with a rather confused conception of the various

subjects treated instead of a strong working framework on which to build. The courses, I believe, should be so taught that the main points are forcibly brought home and inculcated upon the student's mind; and the less essentials treated in a more cursory manner for the student to master at his own convenience as future occasions may demand. First he should receive a strong foundation and framework in the basic principles and theory with as much amplification and explanation as the time available will allow. Then he should receive careful instruction how to build on this foundation and how to go about filling in the framework by study and reading after graduation.

Great care should be taken to see that the courses are properly interrelated; so that the student sees the connection and transition from one subject to another and is able to apply the basic sciences to his professional work. An excellent way to do this is for the department of naval architecture to take the student as soon as he has finished a course in mathematics, physics, mechanics, etc., and put him through an intensive review of the more important parts, and parallel this review with problems in naval architecture and ship construction. For example: The course in mechanics should be reviewed in this manner and those points that have any bearing on naval architecture or marine engineering should be forcibly brought home to the student; and problems on strength and support of deck beams, bulkhead stiffening, longitudinal shear in a ship's structure, and the like, assigned. This method instills in the student a clearer understanding by presenting the subject from an entirely new standpoint.

Before graduation problems should be assigned that will cover the work of several subjects in one problem. These problems will not only test the student's knowledge of the whole course of training but also his common sense, judgment and ability to tackle original problems. For example, a problem on the electrical steering gear for a given ship could be assigned. This would require a knowledge of rudders, the

steering and maneuver of ships; the friction of mechanism, the computation of the power for the steering engine; an investigation of the torque and efficiency of electric motors, and the selection of the proper type of motor for the work.

These suggestions for a course in naval architecture will tend to produce a course that is more practical and purely professional than the general run of engineering courses at present offered. For this reason, it is very essential that purely educational subjects, as history, English literature, and economics be included in the training. The instructors in these subjects should be men of broad education and high ideals; so that the student will have the other side of his character developed by association with men of such quality. For the same reason athletics and other student activities should be encouraged. We must not lose sight of the fact that the graduate should be a leader in the world; one able to meet and sympathize with the problems of the day, as well as to carry on the technical work of naval architecture.

The course of training that I have presented is rather a departure from the present accepted courses given in this country. We should bear in mind, however, that this country is just entering the field of maritime commerce in which other nations are well established. At the outset, we are hampered by labor conditions and seamans' laws that put us at a disadvantage with our competitors. For us to compete successfully with them under these conditions, it is necessary that we design more efficient ships and build and operate them in a more efficient manner. The men who are to carry out this work must be trained in the broadest and most rigid manner. The course that I have outlined was planned with this object in view.

With a course of training as suggested, the student will enter college with a clearer knowledge of his own qualifications, and the scope of his profession; he will pursue his studies with a more appreciative attitude, and will recognize far better the application of theory to practice; he will leave

school with a strong framework of the theoretical, economical and practical branches of naval architecture; and he will have a clearer vision of his future, a more definite purpose, and a more intimate personal knowledge of what is required of him in the industrial world, than the graduates of the past.

PROGRAM OF THE JOINT MEETING OF THE BRITISH EDUCATIONAL MISSION AND THE SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION.

The Secretary received, during the latter part of September, a letter from the Committee for the reception of the British Educational Mission of the American Council on Education, asking the Society to consider holding a joint meeting with the British Educational Mission, December 6–7. The Committee suggested the following topics for discussion: "The Organization of Technical Education in Great Britain and the United States," "The Effect of the War on Technical Education in Great Britain and the United States," and "The Liberal Element in Technical Education." President R. C. MacLaurin offered on behalf of the Massachusetts Institute of Technology to act as host in case such a meeting could be arranged. These topics together with the dates were approved by a vote of the Council.

The Program Committee then prepared the following program, copies being sent to each member of the Society, delegates, presidents of institutions, and others interested in the meeting:

FRIDAY, DECEMBER 6.

2 P.M.

Opening session, Massachusetts Institute of Technology, Cambridge—President John F. Hayford presiding.

Address of Welcome on behalf of the Massachusetts Institute of Technology. R. C. MacLaurin, president, Massachusetts Institute of Technology.

Address of Welcome on behalf of the Society for the Promotion of Engineering Education. John F. Hayford,

president, Society for the Promotion of Engineering Education.

Response to Addresses of Welcome. British Educational Mission to the United States.

The Organization of Engineering Education in Great Britain. Sir Henry Miers, British Educational Mission to the United States.

The Organization of Engineering Education in the United States. Charles S. Howe, president, Case School of Applied Science, Cleveland, O.

Discussion.

7 P.M. Dinner.

SATURDAY, DECEMBER 7.

10:00 A.M.

Morning session, Rogers Building, Boston—President Hayford presiding.

The Effect of the War on Engineering Education in Great Britain. Dr. John Joly, British Educational Mission to the United States.

The Effect of the War on Engineering Education in the United States. C. R. Mann, Massachusetts Institute of Technology.

The Training of Engineers for the U. S. Army. Gen. Wm. M. Black, Chief of Engineers, U. S. Army.

Discussion.

12:30 P.M. Luncheon.

2:00 P.M.

Afternoon session, Rogers Building, Boston—President Hayford presiding.

The Liberal Element in Engineering Education. Rev. Edward Mewburn Walker, British Educational Mission to the United States.

The Liberal Element in Engineering Education. George F. Swain, professor, civil engineering, Harvard University.

Discussion. Adjournment.

MEMBERS OF THE MISSION.

Dr. Arthur Everett Shipley, vice-chancellor of the University of Cambridge, master of Christ's College and reader in zoölogy.

Sir Henry Miers, vice-chancellor of the University of Manchester and professor of crystallography.

The Rev. Edward Mewburn Walker, fellow, senior tutor, and librarian of Queen's College, member of the Hebdomadal Council, Oxford University.

Sir Henry Jones, professor of moral philosophy, University of Glasgow.

Dr. John Joly, professor of geology and mineralogy, Trinity College, Dublin.

Miss Caroline Spurgeon, professor of English literature, Bedford College, University of London.

Miss Rose Sidgwick, lecturer on ancient history, University of Birmingham.

DELEGATES.

Armour Institute of Technology, Chicago, Ill., Professor Howard Raymond.

Akron, University of, Akron, Ohio, Dean Fred E. Ayer.

Brooklyn Polytechnic Institute, Brooklyn, N. Y., President F. W. Atkinson, Dr. Samuel Sheldon.

Brown University, Providence, R. I., Professor W. H. Kenerson, Professor J. E. Hill.

California, University of, Berkeley, Cal., Major C. G. Hyde.

Carnegie Institute of Technology, Pittsburgh, Pa., President A. A. Hamerschlag, Dean W. E. Mott, Professor W. V. Bingham.

Case School of Applied Science, Cleveland, O., President Chas. S. Howe.

Cincinnati, University of, Cincinnati, O., Professor A. M. Wilson.

Colorado School of Mines, Golden, Col., President V. C. Alderson.

Colorado, University of, Boulder, Col., Dean Milo S. Ketchum.
Columbia University, New York, N. Y., Professor G. B. Pegram, Professor M. I. Pupin.
Committee on Education and Special Training, War Department, Brigadier General R. I. Rees.
Cornell University, Ithaca, N. Y., Professor D. S. Kimball.
Delaware College, Newark, Del., President S. C. Mitchell.
Drexel Institute, Philadelphia, Pa., President Hollis Godfrey, Professor Ira W. Fisk.
Harvard University, Cambridge, Mass., Professor A. E. Kennelly, Professor G. C. Whipple, Professor H. J. Hughes.
Iowa State College, Ames, Iowa, Dean Anson Marston.
Iowa, State University of, Iowa City, Ia., Dean W. G. Raymond.
Johns Hopkins University, Baltimore, Md., Professor C. J. Tilden.
Kansas State Agricultural College, Manhattan, Kan., President W. M. Jardine, Dean A. A. Potter.
Kentucky, University of Lexington, Ky., President Frank L. McVey, Dean F. P. Anderson.
Lafayette College, Easton, Pa., President J. H. MacCracken, Professor A. H. Fuller.
Lehigh University, South Bethlehem, Pa., Professor F. P. McKibben.
Leland Stanford Jr. University, Stanford University, Cal., President R. L. Wilbur, Professor C. D. Marx.
Maine, University of, Orono, Me., President R. J. Aley, Dean H. S. Boardman.
Massachusetts Institute of Technology, Cambridge, Mass., President R. C. MacLaurin, Professor W. T. Sedgwick.
McGill University, Montreal, Can., Professor J. B. Porter.
Michigan Agricultural College, East Lansing, Mich., Dean G. W. Bissell.
Michigan, University of, Ann Arbor, Mich., Professor J. R. Nelson.

Michigan College of Mines, Houghton, Mich., President F. W. McNair.

Minnesota, University of, Minneapolis, Minn., President M. L. Burton, Dean Jackson, Dean J. R. Allen.

Missouri, University of, Columbia, Mo., President A. Ross Hill, Dean E. J. McCaustland.

Nebraska, University of, Lincoln, Neb., Dean O. J. Ferguson.

New Hampshire College, Durham, N. H., Dean C. E. Hewitt.

New York University, University Heights, N. Y., Dean C. H. Snow, Professor W. R. Bryans.

Northwestern University, Evanston, Ill., Director J. F. Hayford, Professor H. Crew.

North Carolina, University of, Chapel Hill, N. C., Professor R. H. Doggett.

North Dakota, University of, Grand Forks, N. D., Dean E. J. Babcock.

Oklahoma, University of, Norman, Okla., Professor L. W. W. Morrow.

Ohio State University, The, Columbus, O., Professor Wm. T. Magruder.

Pennsylvania State College, State College, Pa., Dean R. L. Sackett.

Pennsylvania, University of, Philadelphia, Pa., Professor R. H. Fernald.

Pittsburgh, University of, Pittsburgh, Pa., Chancellor S. B. McCormick, Dean F. L. Bishop.

Princeton University, Princeton, N. J., Professor F. H. Constant.

Purdue University, LaFayette, Ind., President W. E. Stone.

Rhode Island State College, Kingston, R. I., President Howard Edwards, Professor R. L. Wales, Professor S. H. Webster.

Rose Polytechnic Institute, Terre Haute, Ind., President C. H. Mees, Professor John White.

Rutgers College, New Brunswick, N. J., Professor F. F. Thompson.

Sheffield S. School—Yale, N. Haven, Conn., Director R. H. Chittenden, Professor J. C. Tracy.

Stevens Institute of Technology, Castle Point, N. J., President A. C. Humphreys.

Syracuse University, Syracuse, N. Y., Dean W. P. Graham.

Throop College of Technology, Pasadena, Cal., Professor A. H. Fleming.

Tufts College, Tufts College, Mass., Dean G. C. Anthony, Professor E. H. Rockwell.

United States Naval Academy, Annapolis, Md., Commander J. L. Hileman.

University of Vermont, Burlington, Vt., Dean J. W. Votey.

Washington University, Saint Louis, Mo., Dean A. S. Langsdorf.

Wentworth Institute, Boston, Mass., Principal A. L. Williston.

West Virginia, University of, Morgantown, W. Va., President F. B. Trotter, Professor J. N. Beahl, Professor O. P. Chitwood.

Wisconsin, University of, Madison, Wis., Dean F. E. Turneaure.

Worcester Polytechnic Institute, Worcester, Mass., President Ira N. Hollis, Professor A. L. Smith.

American Chemical Society, Washington, D. C., Dr. H. P. Talbot.

American Institute of Chemical Engineers, New York, N. Y., Professor J. R. Withrow, Mr. A. D. Little.

American Society of Civil Engineers, 33 W. 39th St., N. Y., Dr. G. F. Swain.

American Institute of Electrical Engineers, 33 W. 39th St., N. Y., Dr. Samuel Sheldon.

American Institute of Manufacturing Engineers, 29 W. 39th St., N. Y., Professor Robt. H. Richards.

American Society of Mechanical Engineers, 29 W. 39th St., N. Y., Professor Clifford B. LePage.

The opening session was held Friday, December 6, at 2:00 P.M. in Room 3–370, southwest wing of the Massachusetts

Institute of Technology, in Cambridge, with President John F. Hayford presiding.

President R. C. MacLaurin welcomed the guests and members of the Society on behalf of the Massachusetts Institute of Technology. President John F. Hayford welcomed them on behalf of the Society for the Promotion of Engineering Education. Dr. Arthur Everett Shipley, vice-chancellor of the University of Cambridge, master of Christ's College and reader in zoölogy, responded to the addresses of welcome on behalf of the members of the British Educational Mission. Unfortunately the members of the British Educational Mission had to leave Boston on Saturday morning and could not, therefore, attend the Saturday sessions. Because of this the addresses by them scheduled for Saturday were delivered on Friday. Meeting adjourned at 4:30.

The Saturday sessions were held in Huntington Hall, Rogers Building, Boston. The morning session was called to order at 10:00 A.M., with President John F. Hayford presiding. The papers, "The Organization of Engineering Education in the United States," by Chas. S. Howe, president, Case School of Applied Science, Cleveland, Ohio, and "The Liberal Element in Engineering Education," by George F. Swain, professor of civil engineering, Harvard University, Cambridge, Mass., were read by title. Dr. C. R. Mann delivered an address on "The Effect of the War on Engineering Education in the United States." General William M. Black delivered an address on "The Training of Engineers for the United States Army." These papers were then discussed. Motion was made and carried that the afternoon session be devoted to the discussion of the reconstruction problems and the bills pending before Congress regarding the engineering experiment research stations.

The afternoon session was called to order at 2:30 P.M. by President Hayford. The meeting was devoted to discussion.

There were one hundred and twenty-three members and guests registered at the meeting. Those registering are:

Frank C. Allen, Gardner C. Anthony, Victor C. Alderson, Frank Aydelotte, F. L. Bishop, G. W. Bissell, Wm. M. Black, G. F. Blessing, H. S. Boardman, Wm. R. Bryans, A. E. Burton, Samuel P. Capen, Lawrence B. Chapman, Norman Collyer, F. H. Constant, Henry Crew, P. H. Daggett, C. R. Dooley, O. J. Ferguson, J. W. Dietz, R. H. Fernald, Chas. E. Ferris, Ira W. Fisk, Desmond FitzGerald, W. S. Franklin, Almon H. Fuller, Lillian M. Gilbreth, Frank B. Gilbreth, Hollis Godfrey, H. M. Goodwin, Louis T. Grant, C. E. Haigler, Miss Sada A. Harbarger, John F. Hayford, H. W. Hayward, Chas. E. Hewitt, Jas. L. Hileman, John E. Hill, H. O. Hofman, Elmer A. Holbrook, Chas. S. Howe, Hector J. Hughes, Charles G. Hyde, S. G. Johndroe, John Joly, Wm. H. Kenerson, Arthur E. Kennelly, Dexter S. Kimball, Carl King, Albert Kingsbury, Howard S. Knowlton, A. S. Langsdorf, J. S. Lapham, Ralph R. Lawrence, F. A. Laws, Clifford B. LePage, E. J. McCaustland, S. B. McCormick, Miss Nell (Mrs.) McKenry, R. C. MacLaurin, Wm. T. Magruder, C. R. Mann, Anson Marston, C. D. Marx, K. G. Matheson, C. L. Mees, Sir Henry Miers, Samuel C. Mitchell, L. W. W. Morrow, William E. Mott, J. Raleigh Nelson, Arthur E. Norton, J. C. Olsen, Henry G. Pearson, George B. Pegram, Ellwood C. Penisho, J. B. Porter, A. A. Potter, Donald B. Prentice, M. I. Pupin, H. M. Raymond, W. G. Raymond, Lepine H. Rice, Robert H. Richards, W. H. Richards, C. W. Ricker, W. M. Riggs, Edward Robinson, Edward H. Rockwell, W. S. Rodman, R. L. Rohrer, R. L. Sackett, Chas. F. Scott, W. T. Sedgwick, Geo. C. Shaad, Samuel Sheldon, Arthur Everett Shipley, Alton L. Smith, Charles H. Snow, Henry P. Talbot, Frank F. Thompson, James S. Thompson, W. O. Thompson, Charles J. Tilden, William H. Timbie, J. C. Tracy, F. E. Turneaure, H. W. Tyler, Mrs. W. L. Upson, W. L. Upson, Edy Velander, J. W. Votey, R. L. Wales, Rev. Edward Newburn Walker, Harrison E. Webb, S. H. Webster, W. C. Whitney, George C. Whipple, Raymond L. Wilbur, W. O. Wiley, Arthur L. Williston, A. M. Wilson, Stanley A. Zweibel.

JOINT MEETING WITH BRITISH EDUCATIONAL MISSION.

An informal dinner was tendered the members of the British Educational Mission on Friday evening in the Hotel Brunswick. There were eighty-seven present at this dinner. On Saturday evening an informal meeting was held in the Hotel Brunswick, at which there was a general exchange of ideas on various topics now confronting the engineering schools. Twenty-eight members attended this meeting.

EDITORIALS.

The special meeting of this Society held in conjunction with the British Educational Mission was in many ways of interest to those who attended, not only on account of the excellent papers and addresses which it was their privilege to hear, but also from the fact that the many questions confronting all engineering schools are such that each man desired to secure the personal opinions of many other teachers of engineering in regard to the problems. It was unfortunate that Professor George F. Swain was called to France just before this meeting. As a result of this his paper on "The Liberal Element in Engineering Education," which appears in this number of the BULLETIN, was read by title. It is not often that this Society has the privilege of having presented to it papers of the character of those at this meeting. The two papers published in this number of ENGINEERING EDUCATION and those that will appear in the January and February numbers are well worth the attention of not only the individual members of this Society, but of the faculties of the schools of engineering in this country.

The Council of the Society voted at the beginning of the war to exempt from dues all members entering service. This together with the other conditions familiar to everyone has led to a considerable decrease in the income of the Society. It is, therefore, imperative that every member should make it a point to secure at least one new member in order that the growth and financial condition of the Society may continue as in the past. If you know any member of your faculty who should be a member, will you send his name to the Secretary?

THE OFFICERS OF THIS SOCIETY HAVE OPPOSED INCREASING THE DUES, ALTHOUGH IT HAS BEEN SUGGESTED BY VARIOUS MEMBERS AT DIFFERENT TIMES. IF EVERY MEMBER PAYS HIS DUES PROMPTLY THERE IS NO NECESSITY FOR SUCH ACTION. IF YOU HAVE OVERLOOKED THIS MATTER, WILL YOU NOT ASSIST THE SOCIETY BY SENDING YOUR CHECK TO THE TREASURER, MR. W. O. WILEY, 432 FOURTH AVENUE, NEW YORK CITY?

COLLEGE NOTES.

The Pennsylvania State College.—One of the engineering buildings at The Pennsylvania State College was recently destroyed by fire, affecting the Departments of Industrial and Mechanical Engineering. A new building was just being completed and a second one has just been begun. Temporary provision has been made for a forge shop and the steam engineering laboratory. Plans for permanent buildings are being considered.

Sheffield Scientific School, which has been since its inception practically a three-year school, has decided beginning with next year to go on the four-year basis.

SOCIETY NOTES.

The BULLETIN and the PROCEEDINGS have been delayed due to the fact that the printers were in quarantine for several weeks on account of the Spanish influenza. It is hoped that the January BULLETIN will appear on time since the material is now in the hands of the printer.

The Proceedings of the Northwestern meeting are in page proof and the volume should be ready for mailing during the month of January.

SOCIETY NOTES.

The March number of the BULLETIN of this Society has been the year book. It is an expensive number to issue and for this reason the Council at the Northwestern meeting directed the officers not to issue the complete year book during the present year but to publish in the March number the changes of titles and addresses of the members. Will you assist us by sending in not only your own changes but any others which you may know have occurred since the last issue of the year book?

This Society is an affiliated society of the American Association for the Advancement of Science and coöperated with the officers of Section D in arranging for the program at the Baltimore meeting, December 26 and 28. The following papers were presented: "The Need of Conservation of Our Vital and Natural Resources as Emphasized by the Lessons of the War," by Henry S. Drinker; "Intensive Training," by C. R. Dooley; "The U. S. Naval Engineering Experiment Station," by Mr. DeBaufre; "Hydraulic Tunneling," by F. J. Trumpour; "The Corona Voltmeter," by J. B. Whitehead; "The Metric System Used in Engineering," by F. A. Halsey. L. A. Doggett, professor of electrical engineering at the U. S. Naval Academy, acted as local secretary and was responsible for the excellent way in which the meeting was conducted.

The Society has received an invitation from The Johns Hopkins University to hold the 1919 meeting at that institution. The Council has taken no action in regard to the next annual meeting. It has been suggested that a large part of the time of the next annual meeting be devoted to the discussion of the Mann report of the Joint Committee on Engineering Education. A special committee of this Society consisting of W. E. Mott, C. S. Howe, L. M. Hoskins, T. U. Taylor and F. H. Constant was appointed at the Northwestern meeting to consider the subject.

BOOK REVIEWS.

Elementary Mathematical Analysis. By CHARLES S. SCHLICHTER, Sc.D., Professor of Applied Mathematics, University of Wisconsin. Second Edition. xvii + 497 pages. McGraw-Hill Book Co., Inc. 1918.

In this edition "changes in order of material and method of treatment have been fully made," some new material has been added and many exercises have been omitted. A separate chapter has been given to the Power Function. Some very good suggestions to students are given in the Introduction on the methods of study of Mathematics. It seems that this is a thing that should be given more attention than it has received in the past and that any text book should contain information of this character.

This book seems to be a correlation of mathematics, but the real test of any such book must be the class room. Some books which attempt to correlate have lost unity and clarity in the manner of treatment. We must not forget that a chapter or even a paragraph that is not "unified or correlated" is much worse pedagogically and psychologically than a book the chapters of which are not so related, and the latter book is worse than a set of books not so related. Instead of dispelling the clouds some books have only succeeded in creating a mist. This criticism is not aimed at the present work, but is merely mentioned to point out to us that many attempts will be made to write a modern book on mathematics while only a few authors, perhaps one or two, will succeed in bringing forth a work that will stand the test of several years in the class room under able instructors but who also may have varying methods of instruction.

F. A. F.

The Chemical Analysis of Iron. By ANDREW A. BLAIR. Eighth edition. 318 pages. 1918. J. B. Lippincott Company, Philadelphia, Pa.

Thirty years ago Blair published "The Chemical Analysis

of Iron," and no one book has dominated more the determination of the constituents of iron and steel.

The eighth edition differs from the seventh in that a great part of it has been recast and rewritten to include improvements in the methods for the determination of the different elements in iron, steel and the ferro alloys. The various methods for each constituent have been grouped together. The factors have been recalculated for the latest atomic weights. The chapter on the analysis of furnace and other gases has been omitted. The chapter on coal analysis has been retained from previous editions. The methods are those recommended in 1899 by the committee on coal analysis for the American Chemical Society. The new methods for coal analysis published in January, 1917, by The American Society for Testing Materials, The American Chemical Society and The American Institute of Chemical Engineers are not mentioned. This edition has but five references to the literature later than the sixth edition.

From the standpoint of engineering education, to train chemists and not to make iron and steel analysts who are not chemists; the place for this book is the reference library. Its sub-title, "A Complete Account of All the Best Known Methods . . . ," gives its scope and its limitations. Usually the methods are given with a wealth of detail on laboratory manipulation and technic; but this book was not designed to teach the chemistry underlying the method. The mastery of this book by the student brings no assurance that he will be able to devise a new method or know which of the given methods may best be used. The rearrangement of the material in this edition gives it increased value as a reference book of methods.

L. E. J.

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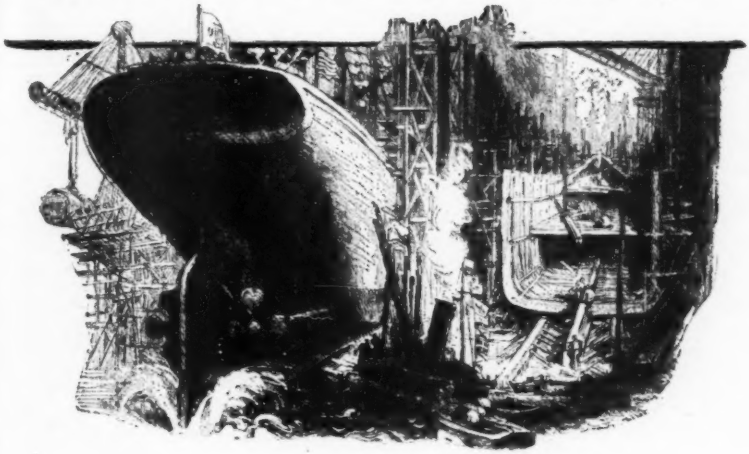

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